The JARPN II program: a critique

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Introduction

In 2000 and 2001, the Government of Japan (GOJ) conducted a "feasibility study" which involved lethal takes of minke (*Balaenoptera acutorostrata*), Bryde's (*B. edeni*) and sperm whales (*Physeter macrocephalus*) in the North Pacific (JARPN II). Although this study provided no testable hypotheses and thus no reasonable criteria by which to judge its results, GOJ has described it as a success, and has subsequently announced that it proposes to carry out a full-scale program of scientific whaling in the North Pacific (SC/54/O2). This program is described as "a long-term research program of undetermined duration", and gives as its primary objectives studies of "feeding ecology and [the] ecosystem", environmental pollutants in cetaceans and in the ecosystem, and stock structure.

According to GOJ (SC/54/O2), the full JARPN II program will repeat the takes of the feasibility study by annually killing 100 minke whales from O and W stocks, as well as 50 Bryde's and 10 sperm whales. However, the new program will include additional catches and species. Specifically, Japan will kill 50 minke whales from coastal waters, and 50 sei whales (*Balaenoptera borealis*) from pelagic areas of the western North Pacific.

Here, we provide a brief critique of the expanded JARPN II program, and contend that it contains serious flaws in design and concept.

Problems with general approaches of JARPN II

Last year, Clapham *et al.* (2002) noted that the JARPN II program lacked any meaningful quantifiable measures by which to judge the study's performance. In a response to this criticism, the Government of Japan (2002) stated that JARPN II was "a feasibility study aimed at testing new and complex research methodologies that will be used towards the ultimate goal of establishing with reasonable precision prey consumption and prey preferences [of whales]". This response further stated that the results of the feasibility study "will be evaluated and necessary modifications will be made before a longer-term programme is implemented", and subsequently listed a series of general questions that were being addressed. However, there was no indication of how the "usefulness" of the data would be judged, nor of how success or failure of the project would be evaluated. SC/54/O2 (the proposal for the expanded JARPN II program) repeats these contentions and questions, again without giving hypotheses to be tested or any indication of performance measures to be employed.

Overall, given the lack of detail and major deficiencies involved, we again contend that the latest JARPN II proposal would not be acceptable by major national and international scientific funding agencies (for example, the European Commission or the National Science Foundation).

We submit that, in addition to the serious problems involved in many details of the study (summarized below), the general experimental design of JARPN II is exceedingly poor. We emphasize that the GOJ needs not only to provide explicit performance criteria for JARPN II, but also describe to the Scientific Committee (SC) the circumstances under which they would conclude that it had *failed* to meet any specific objective of the program.

Overall, it is questionable if the basic design of this program is scientific in the original sense of "scientific" whaling as adopted by the IWC. Rather, JARPN II appears to be a long-term whaling operation without an end point.

Lethal sampling

The JARPN II proposal states that lethal sampling of whales is essential to address the questions being posed in the study. We strongly disagree.

Management of whales under the Revised Management Procedure (RMP) requires a time series of annual catches, a time series of absolute abundance estimates together with their variance/covariance matrix, and a specification of the distributional form of the absolute abundance estimates (IWC 1999, Annex N). We recognize that additional information, while not specified by the RMP, can serve to narrow the set of plausible scenarios considered in Implementation Simulation Trials (ISTs). Stock structure data are particularly useful in this regard, and this fact is justifiably stressed in GOJ (2002). However, the most reliable

information on population structure is obtained from genetic analysis, which can be conducted on skin tissue derived from biopsy samples; lethal sampling is *not* required at all for this research. Furthermore, a biopsy sampling program could generate a much larger sample size which would substantially increase the power of the analyses being conducted.

Similarly, non-lethal methods are available to address the other questions posed by JARPN II. Indeed, in some cases non-lethal techniques yield more reliable results. For example, stable isotope analysis of biopsy tissue provides a long-term signal of diet, and its variation in time; this is in sharp contrast to stomach content analysis, which provides nothing more than a snapshot view of recently consumed prey that is often a misleading indicator of overall diet. This is particularly true in species such as the minke whale which have a large variation in prey species in both space and time.

As noted below, JARPN II is not designed to optimally sample to determine stock structure for use in the ISTs. The SC has noted repeatedly that stock separation is best studied on the breeding grounds, where biopsy is often the only sampling alternative. Interpreting stock structure on migration or even on the feeding grounds when stocks may be mixed is likely to contribute large uncertainties to ISTs.

Finally, it would be impossible to obtain the proposed sampling levels if these were calculated under the RMP. For example, Implementation Simulation Trials (ISTs) for North Pacific minke whales remain incomplete, but preliminary results (Appendix 10, Annex D, *J. Cetacean Res. Manage.* 2002) indicate that few catches would be allowed in sub-area 7. Two example trials that resulted in acceptable levels of final depletion had both low average catches per annum (2.4 and 18.4) and low upper 96th percentiles (17.6 and 34.4). Thus, even the upper 96th percentile suggested a catch (excluding bycatch) far lower than the proposed JARPN II catch of 50 whales. Furthermore, much of the JARPN catch in recent years has come from coastal waters in sub-areas 7 and 11. In addition, there has been incidental catch that exceeds the above catches suggested by the ISTs. Therefore, the proposed use of the coastal whaling fleet for this unnecessary and potentially damaging sampling is not justified.

JARPN II's Ecosystem Studies

General approach: competition between cetaceans and fisheries

JARPN II is described as a multi-species modeling approach to management of whales, and GOJ (2002) states that "development of multi-species management approach [sic] using model approaches is becoming a world standard". However, it should be noted that the management of whales by the IWC under the Revised Management Procedure does *not* currently employ an ecosystem-based approach; whether it should do so has not been discussed to date.

The difficulties of sampling and modeling the myriad variables and complex trophic relationships involved in the marine ecosystem (see, for example, SC/54/E3) make it very unlikely that the program (certainly as currently designed) will yield results that would permit the development of a reliable predictive framework for use in any type of management system.

The JARPN II proposal repeatedly states or implies that the four studied species (minke, Bryde's, sperm and sei whales) all compete heavily with humans for fishery resources. JARPN II is pursuing this issue, and its lethal catches, despite the facts that: a) often large bodies of data on the prey of these whales already exist; b) much of the prey consumed by these animals is not commercially utilized by humans; c) fish, not whales, are the major predators of other fish; and d) human overfishing (rather than whales) is largely responsible for the depletion of fish stocks in the North Pacific and elsewhere (Pitcher 2001).

As an example of the first point, JARPN II proposes to kill "a minimum" of 50 sei whales to examine their stomach contents, despite the fact that it is widely recognized that this species is primarily a predator of copepods. The JARPN II proposal selectively cites past Japanese papers on this topic and omits to mention the largest single study of North Pacific sei whales in the pelagic area: that of Nemoto and Kawamura (1977). This paper, based upon Japanese whaling catches of more than 21,000 whales, showed that very few (only 3.4%) of the sei whales concerned had fish in their stomachs; in contrast, more than 82% of examined whales had been eating copepods. In light of these data, which accord well with dietary information on sei whales elsewhere, it is impossible to see how sei whales could be viewed as a major competitor with human fisheries. Furthermore, the killing of 50 animals a year (which represents a mere 0.2% of the sample already examined by Nemoto and Kawamura 1977) will not add appreciably to the substantial data set

that already exists on the well-known prey preferences of this species.

Similarly, it is widely recognized that sperm whales feed primarily on deep-water squid (as is acknowledged by GOJ in Appendix 3 and Appendix 8 of SC/54/O17). This knowledge of the sperm whale's prey preferences is not based upon trivial sample sizes; indeed, in the 20th century, more than 400,000 sperm whales were killed in the Southern Hemisphere alone (Clapham and Baker 2002), and the stomach contents of a large number of these were examined. A similar situation exists for the North Pacific population. Killing ten sperm whales to determine the diet of this species is redundant and not useful.

Problems with modeling approaches

The JARPN II research plan proposes "to contribute to the conservation and sustainable use of all marine living resources including whales in the western North Pacific, especially within Japan's EEZ." To achieve this goal, JARPN II proposes to use ecosystem models, such as Ecopath with Ecosim and Multspec, "to utilize available information to a maximum and describe dynamic changes including various uncertainties and predict future interactions among cetaceans and fisheries." Of particular interest in this regard are ecosystem responses to the culling of cetaceans, and whether the latter action would create a trophic cascade which will result in increased biomass of commercial fish species.

There are two fundamental problems with this proposal. First, although Ecopath with Ecosim and Multspec are helpful in exploring ecosystem dynamics, they are currently untested in the management arena (Aydin and Friday 2001). Extensive sensitivity analyses of both model assumptions and data inputs are required before such ecosystem models could be used for management. Although the culling of cetaceans may free biomass for use by other species, the ability of ecosystem models to accurately predict which species in the ecosystem will benefit from this freed biomass, and the magnitude of any increase in commercial fish biomass, is unknown. In fact, preliminary studies of a simplified food web indicate that there is considerable uncertainty in the response to culling marine mammals even when climate variability is ignored (Aydin, pers. comm.). In addition, Ecosim results from changing fishing pressure are sensitive to the "vulnerability" parameter, which governs the degree of bottom-up or top-down control in each predator/prey link. While these parameters may be fit to time series data, recent efforts of fitting (e.g. with the Alaska Fisheries Science Center's Eastern Bering Sea Ecosim model) suggest that a large quantity of historical predator/prey, recruitment, and production data for all trophic levels is required to distinguish between top-down control (vulnerabilities of 0.6-0.8) and bottom-up control (vulnerabilities of 0.1-0.3). These parameters must be fit for all trophic levels and take into account environmental variation to avoid the over-optimistic assumptions of yield and predictability that might be derived from an over-responsive model of a food web. To date, systematic tools for evaluating the expected increase in model explanatory power resulting from increased data collection have not been developed.

Second, the ability of Ecopath with Ecosim models to "take account of biological interactions between the different species precisely" is dependent upon the accuracy of the input data for all species in the ecosystem as well as the validity of the assumptions of the modeling technique. Although JARPN II proposes to use an ecosystem framework to examine these biological interactions, little or no information is given on the input data beyond the cetacean species. Limited information is presented on the concurrent prey surveys, and no information is presented on phytoplankton, zooplankton (beyond krill), benthic species, detritus, and fish/squid species not covered by the prey surveys (such as deep water species). Although sensitivity analyses may determine that certain species are less important for exploring specific questions, such analyses have not been presented here, and these lacuna are fatal to this proposal's credibility.

No time step was defined for the ecosystem models. Generally Ecopath and Ecosim use a yearly time step, where input data are averaged over the year; no information is given in the proposal for winter sampling, which is required for such averaging. Migratory species are particularly problematic, since the Ecopath and Ecosim functions to deal with migratory species do not perform adequately. Many researchers average input data for migratory species over the year rather than use these functions. No information is given for residence times for these migratory species.

Finally, any attempt to model ecosystem dynamics *must* account for the major impact of human fisheries. As noted above, over-fishing by humans is widely recognized as the major reason for the decline of fish stocks and for major disruptions of trophic dynamics (Johnston *et al.* 1999, Pitcher 2001). The JARPN II proposal fails to provide details of how fisheries, the recent decline in fish stocks, and this lack of mass-balance will be accounted for in its modeling

approach. It should also be noted that such models require reliable and complete data on the fish catches and bycatch of all nations operating fisheries in the region.

Abundance and population structure

Minke whales

Pelagic zone

Stock Structure: Although the Research Plan states that "the objective was focused on investigating whether or not the W Stock exists in sub-area 9, and if so, to investigate the spatial and temporal extent of its occurrence" the sample sizes (16 and 29) were inadequate. Most samples were taken within sub-area 7 during already sampled seasons. Thus, very little effort went into resolving the O/W stock question.

The two areas that contribute the greatest uncertainty to managing pelagic minke whales are the breeding grounds and the far northern feeding grounds (in particular the Sea of Okhotsk). No mention is made of obtaining samples from the breeding grounds, although such research is fundamental to resolving stock questions and has been repeatedly recommended. Biopsy is mentioned only for the Sea of Okhotsk as a back-up option if lethal sampling is not allowed. Stock structure within this area, which contains half of the total number of western North Pacific minke whales, is such crucial information to proper management that research plans should not be jeopardized by unnecessary lethal sampling. Although the JARPN II proposal states that lethal sampling is justified by the need to obtain "analyses of other biological data such as morphometrics and conception dates" there is not a single case for minke whales in which the genetic data were not sufficient on their own to demonstrate population structure.

Japanese coastal waters

Stock Structure: It is clear that the majority of minke whale samples will be taken in coastal waters. It is now clear that J-stock is present in Japanese coastal waters even on the Pacific side. Substantial numbers of this stock are taken incidentally in Japanese fisheries. The abundance and status of this stock remain unknown, but historically it was heavily harvested and has since incurred high incidental mortalities. There is also apparently additional genetic stock structure within J-stock. Although Japan has indicated that they will not whale in sub-area 11 in April and July to avoid J-stock harvest, there has been no mention of other restrictions despite the new estimates that 22% of the females in this area are J-stock in June and 36% of the males in this area are J-stock in August. Similarly, no restrictions are mentioned for sub-area 7 despite estimates of 13% J-stock females in May, 22% J-stock females in August, and 13% of both males and females in September. Given the whaling history on J-stock, the currently unknown abundance and status and the on-going high incidental catch in at least Japan and Korea, increasing the catch of minke whales in coastal waters cannot be considered consistent with the proposal's statement that "The effects of the research catches will be negligible on whale stocks sampled."

Furthermore, no mention is made of the contributions of both historical samples and market samples to resolve the question of the seasonality of the presence of J-stock.

Bryde's whales

Stock Structure: The Research Plan acknowledges that "weak genetic differences" were found without giving details. The Report of JARPN II (SC/54/O17), Appendix 10, Table 4 compares JARPN II (n = 84) to samples from coastal whaling off Ogasawara (n = 103) and obtains a χ^2 p-value of 0.02 (which is hardly "weak"). Comparisons of these two strata to historical samples from the central western North Pacific (n = 95) were not significant using $\alpha = 0.05$ (p = 0.12 Ogasawara/CWNP, p = 0.17 JARPN II/CWNP), but no power analyses were conducted and sample sizes remain low compared with those for minke whales.

The proposal suggests that Ogasawara should be a future preferred site for lethal sampling in JARPN II because of the above "weak" genetic differences. Targeted whaling around Ogasawara is particularly undesirable because of heavy commercial exploitation in this area during the past and consequently the unknown status of the population in this region.

Sei whales

SC/54/O2 gives an estimate of 28,400 sei whales for the western North Pacific (west of 180 degrees). This figure appears to be based upon an unreviewed estimate of 4,909 derived from JARPN 1997 and JARPN II 2001 surveys, with subsequent

extrapolation using Japanese Scout Vessel (JSV) data. The SC has previously concluded that estimates of minke whale abundance from these type of surveys are not acceptable for use in *Implementation Simulation Trials* because their survey design (e.g., Fig. 3, SC/54/O16) does not lead to estimates that are comparable to estimates from dedicated surveys (SC/54/Rep. 1). Neither has the SC endorsed extrapolations from JSV data (which have, for example, been a serious point of contention for Southern Hemisphere minke whale estimates).

Additionally, no explanation is provided for why encounter rates could be calculated for every year of JARPN and JARPN II (1994-2001), but only those years with the *highest* encounter rates are used for the abundance estimate, while years with the *lowest* encounter rates are not included. Consequently, we regard the unreviewed estimate of 28,400 given in SC/54/O2 as unreliable and unacceptable. No explanation is given for why an estimate has not been made from dedicated vessel surveys that have led to minke whale abundance estimates that are accepted for use in *Implementation Simulation Trials,* and which have led to peer-reviewed publications (e.g., Buckland *et al.* 1992).

Therefore, the examination of the effect on the sei whale population of future catches is also unacceptable, because the examination relies solely on a Hitter population model run using just that single abundance estimate. There has been no IWC review of North Pacific sei whales since 1975. During that review, an assessment concluded that there had been a severe decline in the population, from 42,000 in 1963 to 8,600 in 1974; this was attributed to the intensive exploitation to which sei whales were subject in the North Pacific (Tillman 1977). Furthermore, CPUE-based assessments such as these do not account for increased catch efficiency and are thus likely to result in overly optimistic estimates of population status. In light of the above, we note that the current size and recovery status of the North Pacific sei whale population is unknown. Furthermore, little is known of the stock structure of this population.

In short, the current size and recovery status of the North Pacific sei whale population is entirely unknown. The proposed catches (which would occur in the coastal area, see SC/54/O2, Table 10) would be higher than the coastal catches taken during each of the last three years of the commercial fishery, prior to its closure because of the assumed substantial decline of the population. It is reckless to propose a catch level this high on a stock without any new reliable information upon which to base a new assessment.

Sperm whales

Abundance: The abundance estimate given in the proposal is unreliable and is likely to be heavily positively biased because of the correction factor used. Remarkably, the proposal uses a correction factor developed in the Antarctic where most sightings are of lone males; this is entirely inappropriate given that most sightings in the JARPN II study area are groups of females and young whose surfacing and dive patterns are very different and which are much more available for sighting than are singleton males in high latitudes. As a result, sighting data from such groups require only minimal correction (Barlow & Sexton 1996). Beyond this, Whitehead (SC/54/O6) has noted the need for revision of sperm whale population estimates generally because of invalid analyses of past data.

Finally, we would note that Japanese sperm whale catch data from this region are known to have been falsified and represent underestimates of true catch data (SC/54/O13), which further adds to the uncertainties regarding the status of the population(s) concerned.

Stock Structure: No mention is made of using frozen historical samples although a small sub-sample has already been successfully used to find population structure within the North Pacific (Lyrholm and Gyllensten 1988, Lyrholm *et al.* 1999). The JARPN II proposal also does not mention that two stocks have been documented in coastal Japanese waters and that one of these is likely to be severely depleted (Kasuya and Miyashita 1988).

Ohsumi (1981) has shown that the Japanese coastal sperm whaling grounds covered the entire Japanese coast, but stock structure within this area has long been recognized as a problem. However, the current hypothesis, based on evidence from historical changes in the whaling grounds, the movements of marked whales and monthly changes in blood type composition (Kasuya and Miyashita 1988) is that "Japanese coastal waters include nursery schools (i.e. females, calves, immature) from two putative populations, each breeding to the north and south of the Kurushio/Oyashio front and that the two stocks alternate seasonally of Sanriku (38-42 N) and Hokkaido (42-43 N) regions following the seasonal sifts of the front."

No stock structure results are provided in the report of the 2000 and 2001 feasibility study of JARPN II (SC/54/O17). Yet in the new JARPN II plan the take of ten sperm whales is proposed as a continuation of the original feasibility study. Numerous historical samples exist from the vast sperm whale fishery, plus

samples from recent strandings. These should be used to address the stock structure question. There is no justification for additional catches of sperm whales to address this issue.

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